Foodborne illness: Surveillance, outbreak detection and response

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Key questions about foodborne illness

- How much foodborne illness is there?
  - Compare to other health problems

- Is foodborne illness increasing?
  - Judge progress towards improved food safety

- What are the sources of foodborne illness?
  - Identify opportunities for prevention
1. How much foodborne illness is there?
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- Estimating the human health burden of foodborne illness is an important priority setting step nationally and internationally
  - Enables comparison with other health issues
- The World Health Organization (WHO) has launched the Foodborne Epidemiology Reference Group (FERG)
  - Deriving global estimates of the human health burden of foodborne diseases
- Many causes of foodborne illness
  - >250 foodborne foodborne pathogens described
  - Most foodborne illness, hospitalizations and deaths caused by six pathogens
    - Campylobacter, Salmonella, E. coli, Listeria, Toxoplasma, norovirus
USA population approximately 300 million:

- ~1,300 foodborne outbreaks reported each year
- Estimated 76 million foodborne illnesses resulting in 323,000 hospitalizations and 5,000 deaths annually (1999)
- Health-related costs of 7 major infections: $35 billion
- Up to $1.4 trillion for all societal costs of all foodborne illnesses

Foodborne illness in the United States is due to many different pathogens and toxins

- More than 250 pathogens and toxins transmitted by food
- 6 most important pathogens are:

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Estimated (1999) food-related illnesses</th>
<th>Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Campylobacter</td>
<td>1,900,000</td>
<td>100</td>
</tr>
<tr>
<td>E. coli O157:H7</td>
<td>93,000</td>
<td>75</td>
</tr>
<tr>
<td>Listeria</td>
<td>2,500</td>
<td>500</td>
</tr>
<tr>
<td>Salmonella</td>
<td>1,350,000</td>
<td>550</td>
</tr>
<tr>
<td>Toxoplasma</td>
<td>1,125,000</td>
<td>275</td>
</tr>
<tr>
<td>Norovirus</td>
<td>9,200,000</td>
<td>124</td>
</tr>
</tbody>
</table>

Mead 1999 EID
1. How much foodborne illness is there in the United Arab Emirates (UAE)?

UAE population approximately 4.3 million:
If UAE has the same incidence as the USA, there would be:
- ~18 foodborne outbreaks reported each year
- Estimated 1 million foodborne illnesses resulting in 4,500 hospitalizations and 50 deaths annually (1999)
- Health-related costs of 7 major infections: $500 million
Foodborne illness in UAE is likely caused by many different pathogens and toxins

If the incidence of foodborne illness in UAE is the same as the USA, estimates for the 6 most important pathogens would be:

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Estimated food-related illnesses</th>
<th>Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Campylobacter</em></td>
<td>26,000</td>
<td>2</td>
</tr>
<tr>
<td><em>E. coli O157:H7</em></td>
<td>1,300</td>
<td>2</td>
</tr>
<tr>
<td><em>Listeria</em></td>
<td>35</td>
<td>10</td>
</tr>
<tr>
<td><em>Salmonella</em></td>
<td>19,000</td>
<td>12</td>
</tr>
<tr>
<td><em>Toxoplasma</em></td>
<td>15,000</td>
<td>5</td>
</tr>
<tr>
<td><em>Norovirus</em></td>
<td>125,000</td>
<td>3</td>
</tr>
</tbody>
</table>

Mead 1999 EID
How much foodborne illness is there in UAE?

- Foodborne illness outbreaks – few reported outbreaks
  - Outbreaks may be reported - diagnosis often not confirmed
    - Often reported as “food poisoning” events – but many causes of food poisoning
  - Confirming the etiology of an outbreak requires collection of adequate human specimens and appropriate laboratory testing

- Surveillance for foodborne illness – individual illness
  - Individual illness seldom reported
    - Cause of illness not confirmed by laboratory
  - No existing laboratory-based surveillance
    - Laboratory-based surveillance needed for burden of illness estimates
Determining burden of foodborne illness

- Need surveillance to determine the “tip of the iceberg”
  - “Tip” is the starting point for estimate

- “Under water” proportion depends on several factors
  - Medical care seeking behavior
  - Diagnosis,
  - Reporting
Requirements of laboratory-based surveillance

- Sick people
  - Seek medical care
- Doctor
  - Collect specimen from sick person and submit to laboratory
- Clinical laboratory
  - Isolate pathogen and send isolate to public health laboratory
- Public health laboratory
  - Subtype isolate and report results to health department
- Health department:
  - Interview patient and investigate outbreak
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Routine medical care
Determining the Burden of foodborne illness

- Population exposures
- Person becomes ill
- Person seeks care
- Specimen obtained
- Laboratory tests for organism
- Culture-confirmed case
- Reported to Health Department

“multipliers”
How much foodborne illness is there?

- More illness than recognized
  - Includes unrecognized serious illness (hospitalizations) and deaths
  - Foodborne disease is not just “food poisoning”

- Estimating the human health burden of foodborne illness important for establishing health priorities
  - To increase the priority for food safety, must be willing to acknowledge there is more illness than previously thought
2. Is foodborne illness increasing?
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- Monitoring trends of foodborne illness is essential for judging progress towards improved food safety.
- Requires laboratory-based surveillance system for foodborne illness.
  - Most important pathogens: *Salmonella*, *E. coli*, and *Listeria*.
    - Due to ease in laboratory diagnosis and value of subtyping.
- Surveillance is an essential tool for determining the adequacy of the Food Control System.
Food Control program

- Food Control program (FAO)
  - Food control management
  - Food legislature
  - Inspection
  - Food control laboratory
  - Education and communication

- How do you measure the effectiveness of the food control program?
  - Monitor trends of foodborne illnesses
  - Monitor efficiency of foodborne illness outbreak detection and response
Monitor trends of foodborne illness: Laboratory-confirmed *Salmonella* infections, USA 1996-2008

![Graph showing incidence of laboratory-confirmed Salmonella infections (per 100,000 population) from 1996 to 2008. The graph includes data points for each year and shows a general increase in incidence over the period. The national objective is indicated by a horizontal line at 14.70 per 100,000 population.](image-url)
Monitor trends of foodborne illness: Laboratory-confirmed *Salmonella* infections, USA 1996-2008

![Graph showing incidence of laboratory-confirmed *Salmonella* infections from 1996 to 2008. The graph displays the incidence per 100,000 population, with data points indicating a fluctuating trend. The HP 2010 Objective is 6.80 cases/100,000 persons, and the graph shows a steady increase towards this goal by 2008.](image-url)
Monitor efficiency of foodborne illness outbreak detection and response, USA

- Efficiency of detection
  - High efficiency with development of PulseNet

- Efficiency of response
  - Seeking to improve response
Molecular subtyping: Pulsed-Field Gel Electrophoresis (PFGE)

PFGE identifies “clusters” (infections related in time or place) which need further epidemiological investigation to determine if outbreak
PulseNet

 Participating laboratories

 PFGE patterns

 National database

 Participating laboratories

 PFGE patterns

 National database

 Participating laboratories

 PFGE patterns

 National database
Number of isolates submitted to PulseNet and clusters detected, USA 1996-2008

Bacteria: *E. coli* O157, *Listeria monocytogenes*, *Salmonella*
Molecular “fingerprinting” in public health laboratories now a routine part of surveillance

1996: In one state: 67% increase in *E. coli* O157 outbreaks detected

In all states by 2001, and now identifies each year

- ~1500 clusters at local /state level
- ~300 clusters at national level
- ~10-20 dispersed multistate outbreaks/year – a “new scenario”
  - Most would not previously have been identified
  - Each signals a systemic problem in food safety

Investigation:

- Requires coordinated multi-jurisdiction effort
- Can identify unsuspected problems in production/processing
- Stimulate new regulations, better prevention in industry

Bender 1998 NEJM
Inherent delays in surveillance

Timeline for Reporting of Cases

1 – 3 Days

Patient Eats Contaminated Food

Time to contact with health care system = 1-5 days

Patient Becomes Ill

Stool Sample Collected

Time to diagnosis = 1 – 3 days

Salmonella Identified

Shipping time = 0 – 7 days

Public Health Lab Receives Sample

Serotyping and “DNA fingerprinting” 2-10 days

Case Confirmed as Part of Outbreak
Is foodborne illness increasing?

- Monitoring trends is essential for judging progress towards improved food safety
  - Important tool for judging adequacy of food control system
- Requires laboratory-based surveillance system
3. What are the sources of foodborne illness?
Outbreak investigations to determine source of foodborne illness, SA

- Immediate control of hazard, halting an outbreak
  - Closing a restaurant or food production facility
  - Recalling a contaminated product
- Long term prevention through safer processing, inspection, enforcement and training
  - Information from outbreaks and other studies informs change in regulations, industry and consumer practices, and to reduce the incidence of infections
Examples of successful recent prevention efforts, USA

- Juice–associated outbreaks
  - 1990’s: Large outbreaks traced to commercial unpasteurized juices (2/y)
  - 1998: First FDA regulation, required label on raw juice indicating hazard
  - More outbreaks occurred due to unpasteurized juices
  - 2004: FDA required pathogen reduction step for all juice processors
  - Only two outbreaks since due to contaminated commercial juice

- *E. coli* O157:H7 and ground beef.
  - 1990’s: large outbreaks propelled major changes in meat industry
  - Focus: decontaminating carcasses – little change in *E. coli* O157
    (Ground beef is made from beef trimmed from the carcasses)
  - 2002: New effort focused on trim, with voluntary testing
  - 2003: O157 incidence and ground beef contamination dropped
Summarize outbreaks: A broad range of foods can be contaminated

- Prevention often focuses on specific foods
- 2003-2007: Illnesses in outbreaks caused by single foods
- 10 new food vehicles identified in multistate outbreaks since 2006
  - bagged spinach
  - carrot juice
  - peanut butter
  - broccoli powder on a snack food
  - dog food
  - pot pies
  - canned chili sauce
  - hot peppers
  - white pepper
  - raw cookie dough

Source: National Foodborne Outbreak Surveillance System
What are the sources of foodborne illness?

- Immediate purpose of a outbreak investigation
  - Summary of outbreak investigations are useful for policy
- Determining sources facilitates prevention
Conclusion

- Essential need for laboratory-based surveillance
  - Determine burden of illness
  - Monitor trends
  - Leads to investigations that determine sources
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